

combination of references fails to disclose or suggest a device for controlling an internal combustion engine with a variable valve system wherein, while a piston of the engine descends during an expansion stroke in a cylinder of the engine, an intake valve is opened by the variable valve system for the intake valve such that intake air is supplied into the cylinder from the engine intake system, and pressure in the cylinder is lowered by opening an exhaust valve at an initial stage of the expansion stroke by the variable valve system for the exhaust valve before said intake valve is opened, as recited in amended claim 1.

The Office Action alleges that the primary reference of Whiting discloses an air intake valve that is opened while a piston of the engine descends during an expansion stroke in a cylinder of the engine. However, as previously pointed out in the May 12, 2005 Amendment, Whiting offers no such description or disclosure of the position or control of either of the disclosed intake valves 18. As shown in Fig. 3 of Whiting, a graph of the combustion chamber pressure versus crank angle illustrates the position of the valves during exhaust gas recirculation. As clearly shown in Fig. 3, only the secondary exhaust valves 20 are opened during the expansion phase of the piston cycle, which is occurring between 0 and 180 degrees of crank angle. The secondary exhaust valve is shown as SEVO (secondary exhaust valve opened) and SEVC (secondary exhaust valve closed). In contrast, the intake valve open (IVO) is shown as occurring during the exhaust phase and the intake valve close (IVC) is occurring just after the completion of the intake phase (see also Fig. 5). Thus, Figs. 3 and 5 clearly show that the intake valve is not opened until the exhaust phase just prior to the 360 degree crank angle. Accordingly, Whiting fails to disclose the features as alleged in the Office Action.

Additionally, it is admitted in the Office Action that Whiting fails to disclose opening an exhaust valve at an initial stage of the expansion stroke ... before the intake valve is opened. To overcome the admitted deficiency, the Office Action combines Bryant and

alleges that it would have been obvious to one of ordinary skill in the art at the time the invention was made to make the combination, thereby rendering the rejected claims obvious. In support of the allegation, it is alleged in the Office Action that Bryant discloses such a feature at col. 30, line 32 - col. 36, line 34 which describes a 2-stroke operation of a Miller Cycle engine.

Bryant discloses a method of deriving mechanical work from combusting gas in an internal combustion engine by means of a thermodynamic working cycle (col. 1, lines 10-15). It is disclosed in Bryant that the invention may be used in either a 4-stroke or 2-stroke Miller Cycle engine. However, Bryant fails to disclose the opening of an exhaust valve at an initial stage of expansion before opening an intake valve. For example, Bryant discloses that for a 4-stroke engine the intake valves are timed to allow the introduction of charged air into the power cylinder during the intake stroke with the intake valve closing at a point substantially before piston bottom dead center of the intake stroke or, alternatively, with the intake valve closing at some point during the compression stroke (see col. 3, lines 14-22).

Bryant also discloses that for the 2-stroke engine the intake valves are timed to operate such that the charged air is maintained within the transfer manifold and introduced into the power cylinder during the scavenging compression stroke at such a time that the power cylinder has been scavenged by low pressure air and the exhaust valve has been closed (col. 3, lines 29-36). Thus, in either a 4-stroke or a 2-stroke engine. Bryant fails to disclose that the exhaust valve is open at an initial stage of the expansion stroke before the intake valve is opened.

Reviewing the cited sections of Bryant, i.e., col. 30, line 32 - col. 36, line 34, there is no disclosure of the feature recited in the rejected claims. The cited sections of Bryant reveal that the opening and closing of the inlet valve 16 and the exhaust valve 17 are controlled by the engine control module 27 (col. 31, lines 54-57). For example, in the 2-stroke engine

described in Bryant, the exhaust valves 17, 17' are opened near the end of the power stroke, and remain open at the beginning of the second or exhaust stroke. At the point the exhaust valves are closed the intake valves are opened at that point or later in the compression stroke (see col. 31, line 64 - col. 32, line 4). Bryant also disclosed the opening of the exhaust valves during the exhaust stroke (col. 32, lines 27-36).

In a second alternate operation method, Bryant again discloses that the exhaust valves 17, 17' are open near the end of the power stroke (col. 32, lines 41-42). However, nowhere in Bryant is there a disclosure of the exhaust valves being opened at an initial stage of expansion before the opening of the intake valve, as alleged in the Office Action.

Finally, the cited reference of Born is applied merely to demonstrate that electromagnetic valve actuators were available at the time of this invention. Accordingly, as none of the references, whether considered alone or in combination disclose each and every feature recited in the rejected claims, withdrawal of the rejection of claims 1, 3, 5, 6, 10 and 12 under 35 U.S.C. §103(a) is respectfully requested.

Claims 1, 3 and 5 are rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,398,502 to Watanabe in view of Bryant. The rejection is respectfully traversed.

Although the Office Action cites the Watanabe reference, the Office Action describes the previously cited reference of Whiting as disclosing the features in the rejected claims. However, the rejection of claims 1, 3 and 5 under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of Bryant will be discussed in reference to those patents and not the previously applied reference to Whiting.

Neither Watanabe nor Bryant disclose or suggest, a device for controlling an internal combustion engine with a variable valve system wherein, while a piston of the engine descends during an expansion stroke in a cylinder of the engine, an intake valve is opened by the variable valve system for the intake valve such that intake air is supplied into the cylinder

from the engine intake system, and pressure in the cylinder is lowered by opening an exhaust valve at an initial stage of the expansion stroke by the variable valve system for the exhaust valve before said intake valve is opened, as recited in claim 1.

Watanabe discloses an intake valve 11 and an exhaust valve 13 that communicate with a combustion chamber 8 (see Fig. 1). However, as clearly shown in Figs. 4 and 5 of Watanabe, the intake valve is opened during the intake phase at a small angle shown by the line IN1, and at a large angle opening during the intake phase, as shown in line IN2. Thus, Watanabe fails to disclose opening the intake valve during the expansion stroke as alleged in the Office Action.

Additionally, the Office Action admits that Watanabe fails to disclose the additional feature of the exhaust valve being opened before the intake valve during the expansion stroke. To overcome the admitted deficiency the Office Action again combines Bryant for its alleged teaching of opening the exhaust valve as recited in the claims. However, as discussed above, Bryant fails to disclose the alleged feature. Rather, Bryant merely discloses the opening of the exhaust valves near the end of the power stroke, rather than at an initial stage of the expansion stroke as recited in the rejected claims. Thus, the combination of references fails to disclose each and every feature recited in the rejected claims. Accordingly, withdrawal of the rejection of claims 1, 3 and 5 under 35 U.S.C. §103(a) is respectfully requested.

Claims 6, 10 and 12 are rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of Bryant and further in view of Born; claims 2 and 7 are rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of Bryant and further in view of U.S. Patent No. 3,953,969 to Mori; and claims 2, 7 and 9 are rejected under 35 U.S.C. §103(a) as unpatentable over Whiting in view of Born and further in view of Bryant and further in view of Mori. The rejections are respectfully traversed.

Each of claims 2, 6, 7, 9, 10 and 12 are allowable for their dependency on independent claim 1 for the reasons discussed above, as well as for the additional features recited therein. Furthermore, as Mori fails to overcome the deficiencies discussed above, withdrawal of the rejection of claims 2, 6, 7, 9, 10 and 12 under 35 U.S.C. §103(a) is respectfully requested.

Claims 1, 3 and 5 are rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of U.S. Patent No. 6,237,551 to Macor et al. (Macor). The rejection is respectfully traversed.

As discussed above, Watanabe fails to disclose or suggest the opening of an intake valve while a piston of an engine descends during an expansion stroke. Additionally, it is admitted in the Office Action that Watanabe fails to disclose the feature of an exhaust valve being opened before the intake valve is opened during the expansion stroke.

To overcome the admitted deficiency, the Office Action combines Macor and alleges it would have been obvious to one of ordinary skill in the art at the time of the invention to make the combination, thereby rendering the rejected claims obvious. The Office Action alleges that Macor teaches a multi-cylinder diesel engine that opens an exhaust valve before the intake valve is opened during a piston expansion stroke in a 2-stroke operation, as shown in Fig. 9 of Macor.

Fig. 9 of Macor is described as a diagram showing the opening strokes of the intake and exhaust valves in the mode of operating the engine as a brake (col. 4, lines 50-53). During the braking mode of operation a 2-stroke cycle is obtained having an active compression stroke at each piston upstroke towards the top dead center, and an intake stage with full filling of the cylinder at each piston downstroke. It is important to note that during operation of the diesel motor in the braking mode of operation, that no fuel is injected into the cylinder. Accordingly, there is no expansion stroke in the motor during this mode of

operation (col. 7, lines 43-49). Thus, the engine merely acts as a compressor to aid in the braking of the vehicle (col. 7, line 27).

Macor does disclose that at the end of each piston upstroke, i.e., the active compression stroke previously described, the exhaust valve is opened so that the maximum pressure within the cylinder does not raise above a given predetermined value (col. 7, lines 28-31). Thus, Macor merely discloses that the exhaust valve is opened during an active compression stroke. Accordingly, as the combination of references fails to disclose each and every feature recited in the rejected claims, withdrawal of the rejection of claims 1, 3 and 5 under 35 U.S.C. §103(a) is respectfully requested.

Claims 1, 3, 5, 6, 10 and 12 are rejected under 35 U.S.C. §103(a) as unpatentable over Whiting in view of Born and further in view of Macor. The rejection is respectfully traversed.

As discussed above, Whiting fails to disclose the opening of an intake valve during an expansion stroke in the cylinder of an engine and Born merely describes the use of an electromechanical variable valve actuator. As Macor fails to disclose an exhaust valve that is opened during an initial stage of an expansion stroke but before the intake valve is opened, as discussed above, the combination of references fails to disclose or suggest the features as alleged in the Office Action. Accordingly, withdrawal of the rejection of claims 1, 3, 5, 6, 10 and 12 under 35 U.S.C. §103(a) is respectfully requested.

Claims 6, 10 and 12 are rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of Macor and further in view of Born; and claims 2 and 7 are rejected under 35 U.S.C. §103(a) as unpatentable over Watanabe in view of Macor and further in view of Mori. The rejections are respectfully traversed.

Claims 2, 6, 7, 10 and 12 are allowable for at least their dependency on independent claim 1 for the reasons discussed above, as well as for the additional features recited therein.

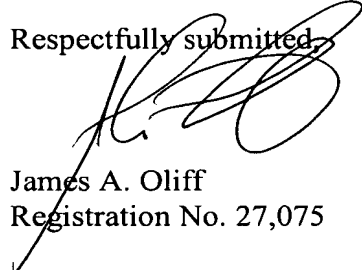
Furthermore, as Mori fails to overcome the previously described deficiencies, withdrawal of the rejection of claims 2, 6, 7, 10 and 12 under 35 U.S.C. §103(a) is respectfully requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 1-3, 5-7, 9, 10 and 12 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,


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